UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6032986348

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **May/June 2012**

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **both** questions.
You will be allowed to work with the apparatus for a maximum of one hour for each question.
You are expected to record all your observations as soon as these observations are made, and to plan the presentation of the records so that it is not necessary to make a fair copy of them.
You may lose marks if you do not show your working or if you do not use appropriate units.

Additional answer paper and graph paper should be used only if it becomes necessary to do so.
You are reminded of the need for good English and clear presentation in your answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1	
2	
Total	

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1 In this experiment, you will investigate how the motion of a pendulum whose swing is interrupted depends on its length.

(a) (i) Lay the pendulum next to the rule and use the pen to make a mark on the string so that the distance L is 0.180 m, as shown in Fig. 1.1.

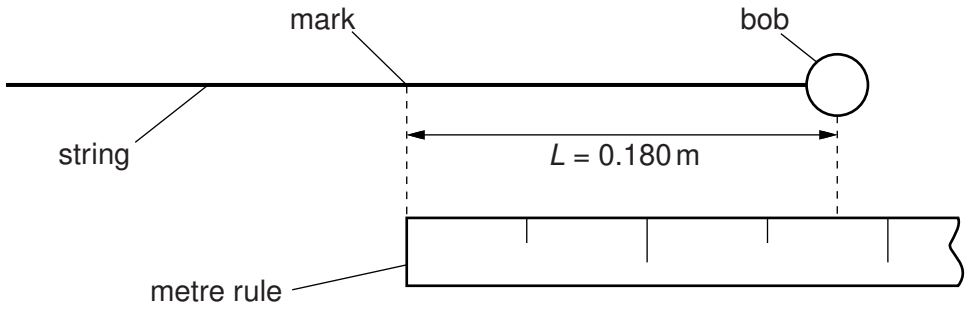

Fig. 1.1

(ii) Set up the apparatus, fixing the string in the split bung so that the string is just touching the wooden rod at the mark you have made.

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Fig. 1.2 shows a side view and a front view of the apparatus.

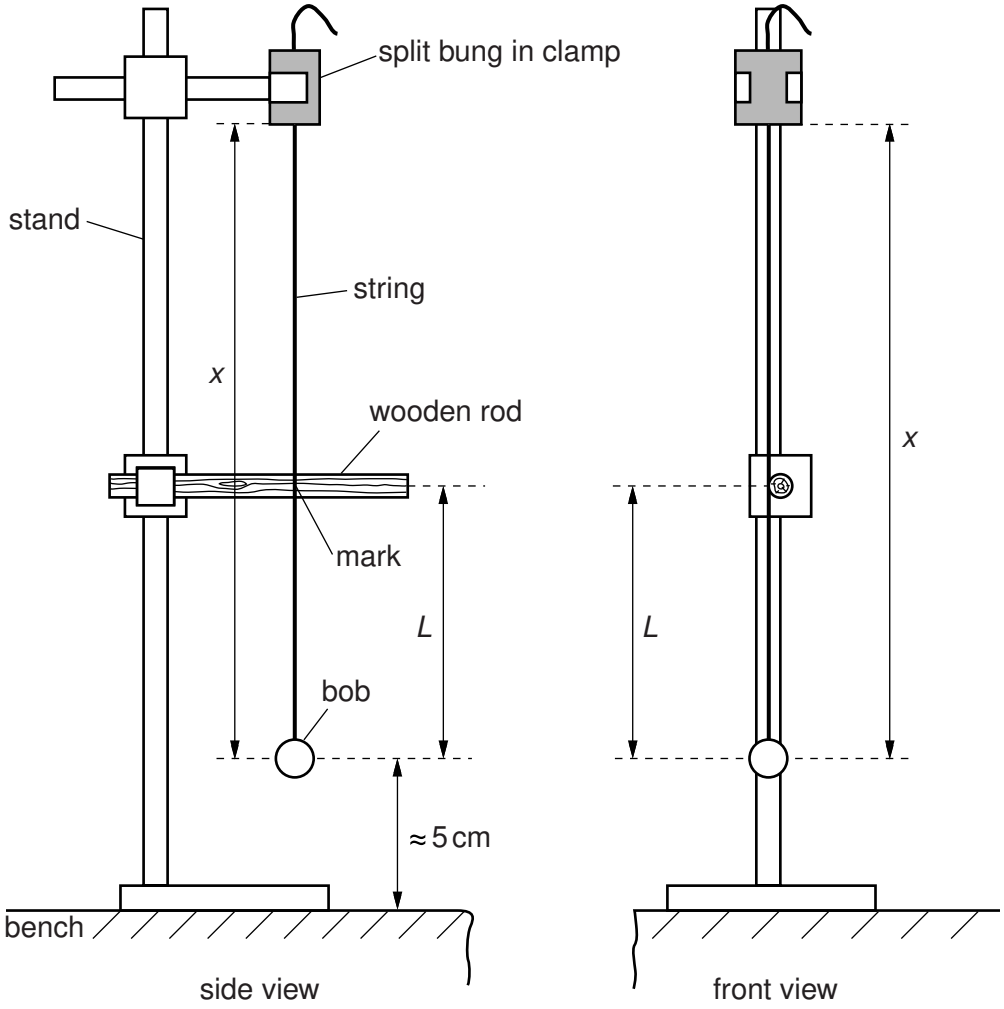

Fig. 1.2

The centre of the bob should be approximately 5 cm above the bench.

The distance *x* between the bottom of the bung and the centre of the bob should be approximately 55 cm.

The mark on the string should be level with the centre of the rod.

(iii) Measure and record the distance *x*.

x = ... m [1]

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(b) (i) Move the bob sideways through a distance of approximately 5 cm, as shown in Fig. 1.3.

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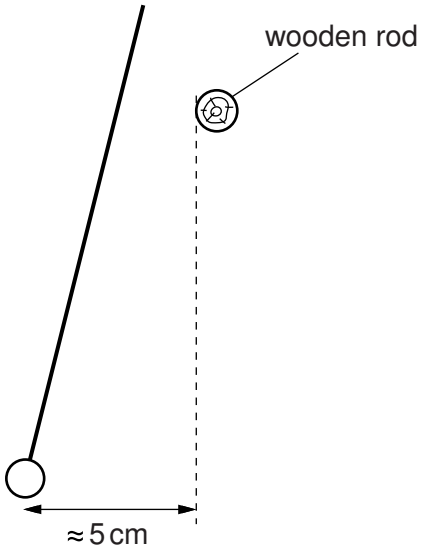

Fig. 1.3

(ii) Release the bob and watch its movement. The bob will move to the right and then to the left again completing a swing, as shown in Fig. 1.4. Let the pendulum swing to and fro, counting the number of swings.

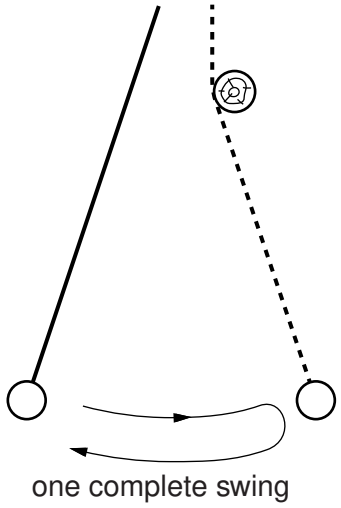

Fig. 1.4

Measure and record the time for at least 10 consecutive swings.

Record enough readings to determine an accurate value for the time T taken for one complete swing.

T = ... [2]

(c) Reduce the distance x. Keep L constant, by adjusting the height of the wooden rod if necessary. Repeat **(a)(iii)** and **(b)** until you have six sets of values of x and T.

Include values of $\sqrt{x}$ in your table.

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[9]

(d) (i) Plot a graph of T on the y-axis against $\sqrt{x}$ on the x-axis. [3]

(ii) Draw the straight line of best fit. [1]

(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]

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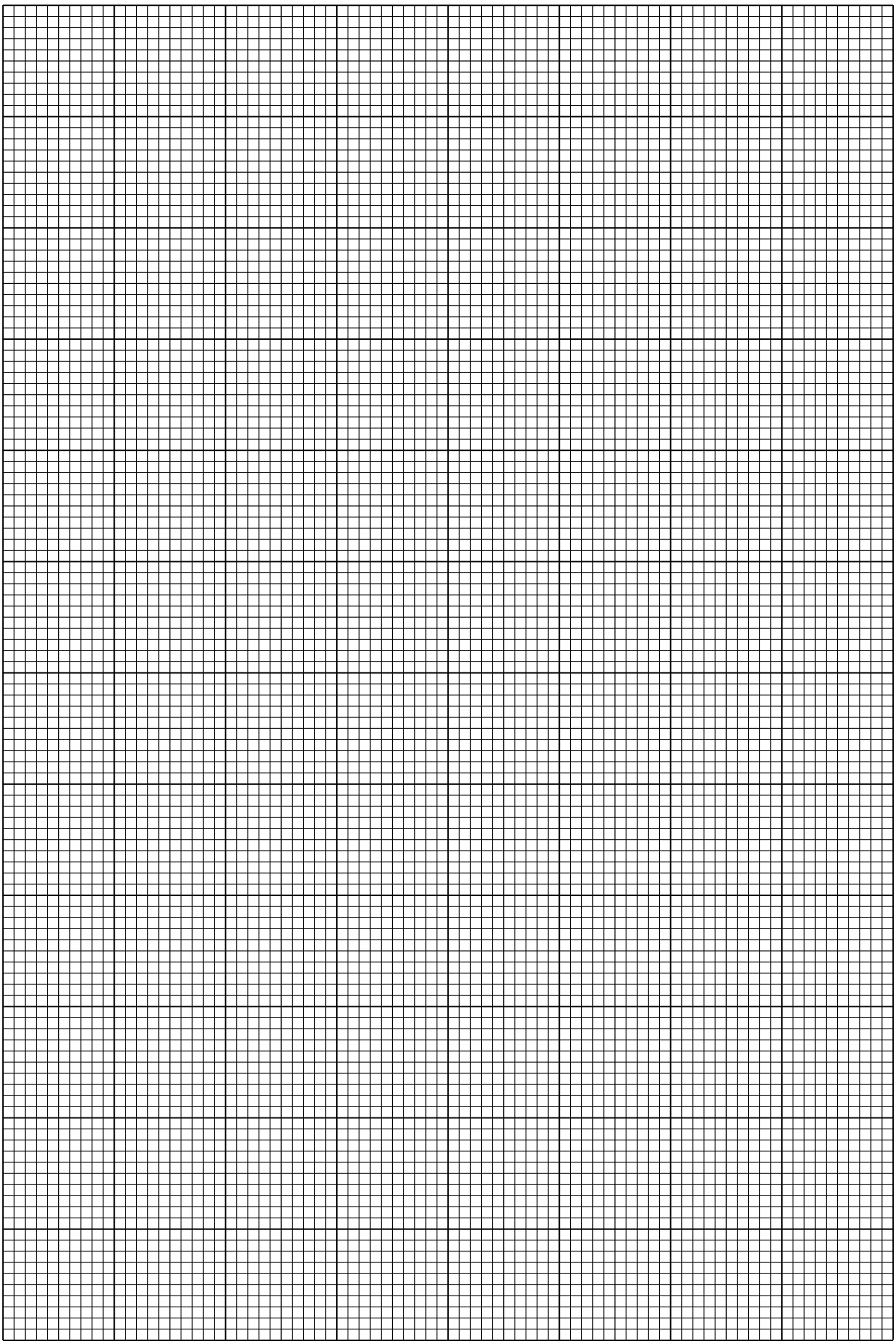

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(e) The quantities T and x are related by the equation

$$T = P\sqrt{x} + Q$$

where P and Q are constants.

Using your answers from **(d)(iii)**, determine the values of P and Q.

Give appropriate units.

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$P =$ .....

$Q =$ .....

[2]

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2 In this experiment, you will investigate how the force required to pull a block up an inclined plane depends on the angle between the inclined plane and the bench.

(a) (i) Place the board on the bench.

(ii) Place the block with attached masses on the board, and attach the newton-meter as shown in Fig. 2.1.

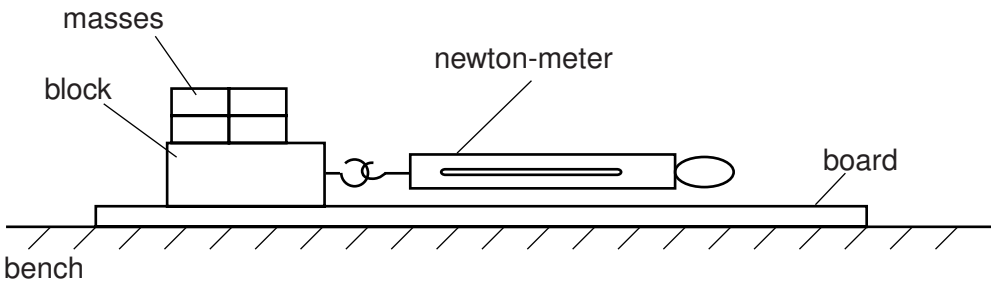

Fig. 2.1

(iii) Gently pull the newton-meter until the block just starts to move.

Measure and record the reading F_0 on the newton-meter, at the instant the block just starts to move.

F_0 = ... [2]

(iv) Estimate the percentage uncertainty in your value of F_0.

percentage uncertainty = ... [1]

(v) Calculate μ where $\mu = \frac{F_0}{W}$.

W is the value of the weight of the block and masses written on the card.

μ = ... [1]

(b) (i) Place the board and supporting block as shown in Fig. 2.2. The longer edge of the supporting block should be vertical.

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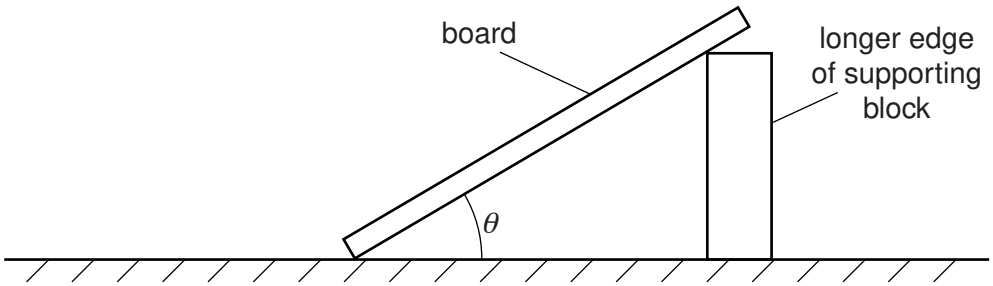

Fig. 2.2

(ii) Using the protractor, measure and record the angle θ between the board and the bench.

θ = ... [1]

(iii) Using your values from **(a)(v)** and **(b)(ii)**, calculate $(\sin\theta + \mu\cos\theta)$.

$(\sin\theta + \mu\cos\theta)$ = ... [1]

(c) (i) Place the block with masses on the board and attach it to the newton-meter, as shown in Fig. 2.3.

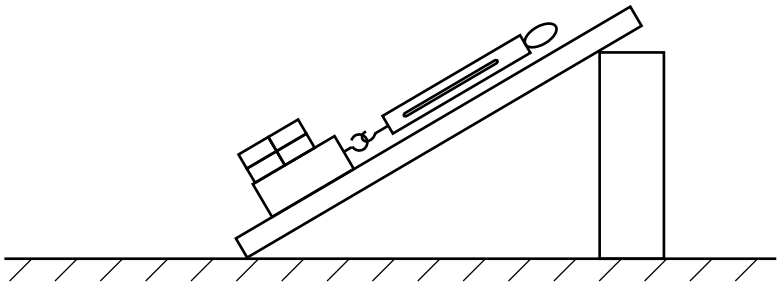

Fig. 2.3

(ii) Pull the newton-meter until the block just starts to move.

Measure and record the reading F on the newton-meter.

F = ... [1]

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(d) Place the supporting block as shown in Fig. 2.4 with a shorter edge vertical.

Repeat **(b)(ii)**, **(b)(iii)** and **(c)**.

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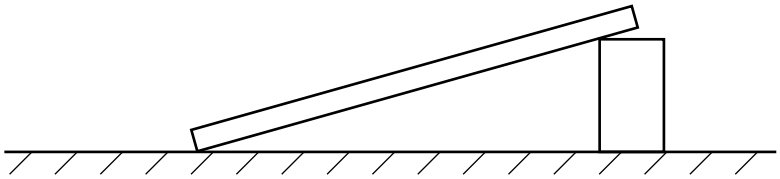

Fig. 2.4

θ = ...

$(\sin\theta + \mu\cos\theta)$ = ...

F = ...

[3]

(e) It is suggested that the relationship between F and θ is

$$F = k(\sin\theta + \mu\cos\theta)$$

where k is a constant and μ is the value calculated in **(a)(v)**.

(i) Using your data, calculate two values of k.

first value of k = ...

second value of k = ...

[1]

(ii) Explain whether your results support the suggested relationship.

.....

.....

.....

.....[1]

(f) (i) Describe four sources of uncertainty or limitations of the procedure for this experiment.

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1. .....

.....

2. .....

.....

3. .....

.....

4. .....

.....

[4]

(ii) Describe four improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1. .....

.....

2. .....

.....

3. .....

.....

4. .....

.....

[4]

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